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Research Article

A bilateral gynandromorph of *Aedes* (*Ochlerotatus*) *punctor* (Kirby, 1837) from Germany (Diptera, Culicidae)

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Abstract

A completely bilateral gynandromorph of *Aedes* (*Ochlerotatus*) *punctor*, reared from a larva collected from a natural habitat in the German Volcanic Eifel region, is described and figured. In dorsal view, its right side is of female, the left side of male morphology. Only the external genitalia appear to be a mosaic, with male hypopygia dominating.

Zusammenfassung

Ein vollständiger Halbseiten-Gynandromorph von *Aedes* (*Ochlerotatus*) *punctor*, dessen Imago aus einer in der deutschen Vulkaneifel gesammelten Larve gezüchtet wurde, wird beschrieben und abgebildet. In Dorsalansicht ist die rechte Körperseite weiblich, die linke männlich ausgebildet. Lediglich die äußeren Genitalanhänge scheinen teilweise ein Mosaik darzustellen, bei dem die männlichen Hypopygien jedoch dominieren.

Key Words

Medical entomology, Mosquitoes, Aedini, Europe, Rhineland-Palatinate, Stinging Canadian Pointy Mosquito

Schlüsselwörter

Medizinische Entomologie, Aedini, Europa, Rheinland-Pfalz, Stinging Canadian Pointy Mosquito

Introduction

Gynandromorphism is a rarely observed sexual polymorphism in mosquitoes (Culicidae). In a strict sense, the condition describes the individual presence of both strictly male and strictly female characters, whereas intersexes show intermediate structures (Kronefeld et al. 2014). The condition can develop either as bilateral, bipolar or as oblique gynandromorphs, depending on the degree and symmetry of the visible dimorphism.

Warren and Hill (1947), and Roth (1948) reported a frequency of 0.0025‰, which is one in 400,000, in U.S. mosquitoes. In Germany, to the best of my knowledge, only cases of mosaic and (bi)- polar gynandromorphs have been described so far, including two specimens of *Ae. punctor* recorded by Brelje (1923) and Kronefeld et al. (2014).

A completely bilateral gynandromorph of *Ae. punctor*, reared from a larva collected from a natural habitat, is described herewith.

Material and methods

Mosquito larvae (L3–L4 instars) were collected with a dipper bowl from Strohner Määrchen, an aquatic habitat near the village of Strohn in the Volcanic Eifel region in Rhineland-Palatinate (50°10'48"N, 06°53'03"E; 424 m.a.s.l.), in March 2024 (air temperature approx. 9 °C). In the laboratory the larvae were reared at room temperature, and were allowed to pupate and emerge in a "BugDorm-1" collapsible insect rearing cage (MegaView Science Co., Ltd., Taichung, Taiwan). After hatching the imagines were transferred into a 25 ml glass tube and kept in the dark for approx. 24 hrs to allow the cuticle to harden, after which they were killed by freezing at -40 °C.

Microscopic examination and digital imaging were carried out either with a Leica M125C stereo-microscope (Leica Microsystems AG, Heerbrugg, Switzerland) with attached camera MC190HD, workstation and Leica software, or with a Zeiss Axioscope 5 compound microscope with attached Axiocam 208 color camera (Carl Zeiss Microscopy Deutschland, Oberkochen, Germany).

Genitalia were carefully removed, then macerated in 3% potassium hydroxide (Remel/Thermo Fisher Scientific, Lenexa, Ks., USA), and finally mounted in 54 °C pre-heated Phenol-free Kaiser's glycerol gelatine (Sigma Aldrich/Merck KGaA, Darmstadt, Germany). In order to avoid further destructive measures on the unique gynandromorph, its tarsal ungues were only inspected on the intact specimen in a dry state, whereas for comparison, representative specimens of typical female and male tarsi were mounted in Euparal (Carl Roth GmbH, Karlsruhe, Germany). Morphological determination was carried out following the identification keys of Mohrig (1969) and Becker et al. (2020). The nomenclature of the morphological features of the specimen described follows Harbach and Knight (1980). Both the specimen and the mounted slide are deposited in the entomological collection of the Medical Zoology/Entomology lab of the BundeswehrZentralkrankenhaus Koblenz (specimen in -40 °C frozen state).

Results

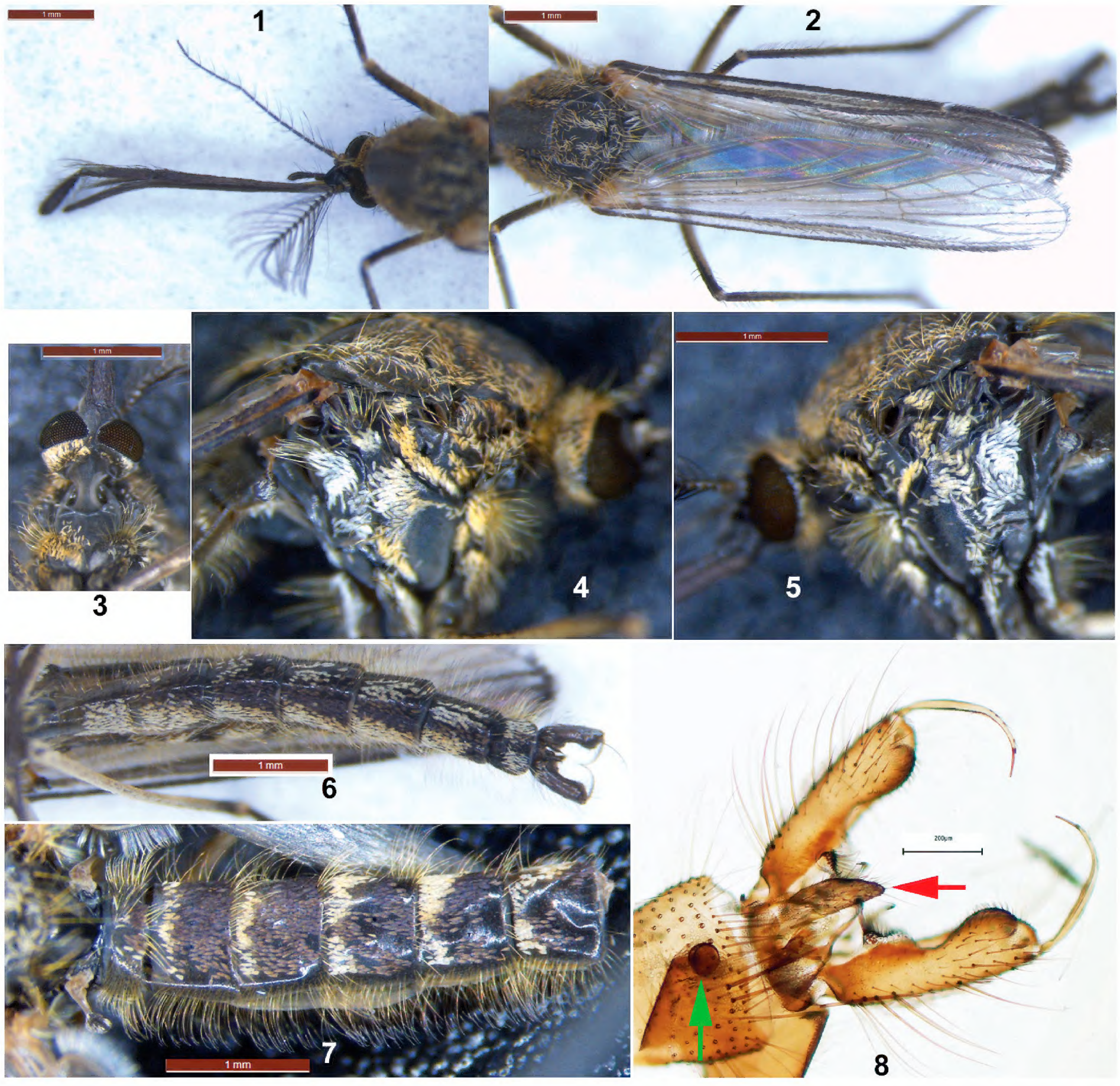
Out of approximately 50 collected larvae, 23 typical imagines of *Ae. punctor* emerged: 11 males, 12 females. In addition, one aberrant specimen turned out to be a completely bilateral gynandromorph, with its right side of female, the left side of male morphology.

The specimen's head (Fig. 1) carries a female antenna and short maxillary palpus on the right side, and a male antenna and long maxillary palpus on the left side. The female-like right wing is more densely covered with dark scales than the left wing, the latter being slightly longer than the right wing (Fig. 2). On the legs, the ungues (tarsal claws) also express a completely bilateral partition: female-like on the right side and male-like on the left side (fore- and mid-tarsi particularly). In the female condition all ungues are similar and bear a subbasal pointed, curved tooth. In the male condition the outer ungues of the fore- and mid-tarsi are much bigger (with that of the mid-tarsus somewhat straighter), and their subbasal tooth is rather thumblike than curved. Regarding the thorax it is mostly the ventral aspect (Fig. 3) which shows bilateral partition: the female-like pleurites and fore-coxa are more densely covered with scales and setae, which are of yellowish-golden color, whereas the male-like side is less prominently patterned. The dimorphism is less prominent on the pleuron (Figs 4, 5). The female side of the abdominal tergites and sternites (Figs 6, 7) has larger pale-scaled patches than the male side. Eventually, only the external genitalia (Fig. 8) appear to be a mosaic, with male genitalia dominating and fully expressed, whereas on the female side there is only an unpair and slightly shrunken cercus dorsal of the male genitalia structures, and internally spermatheca with only one spermathecal capsule.

Regarding the sexually dimorphic ungues, a typical female and a typical male of *Ae. punctor* from the same collection were dissected and the respective ungues of fore-, mid- and hind-tarsi were documented for comparison (Figs 9–14). Their shapes correspond to the description given above for the gynandromorph's right side (female-like) and left side (male-like), respectively.

Discussion

Gynandromorphs are defined as genetically chimeric or sexual mosaic individuals respectively, with phenotypic traits of both sexes (Narita et al. 2010). However, the condition can be difficult to discriminate from intersexualism, where external structures are intermediate between sexes, while the individual is genetically determined. Hence, only genotyping can ultimately differentiate be-



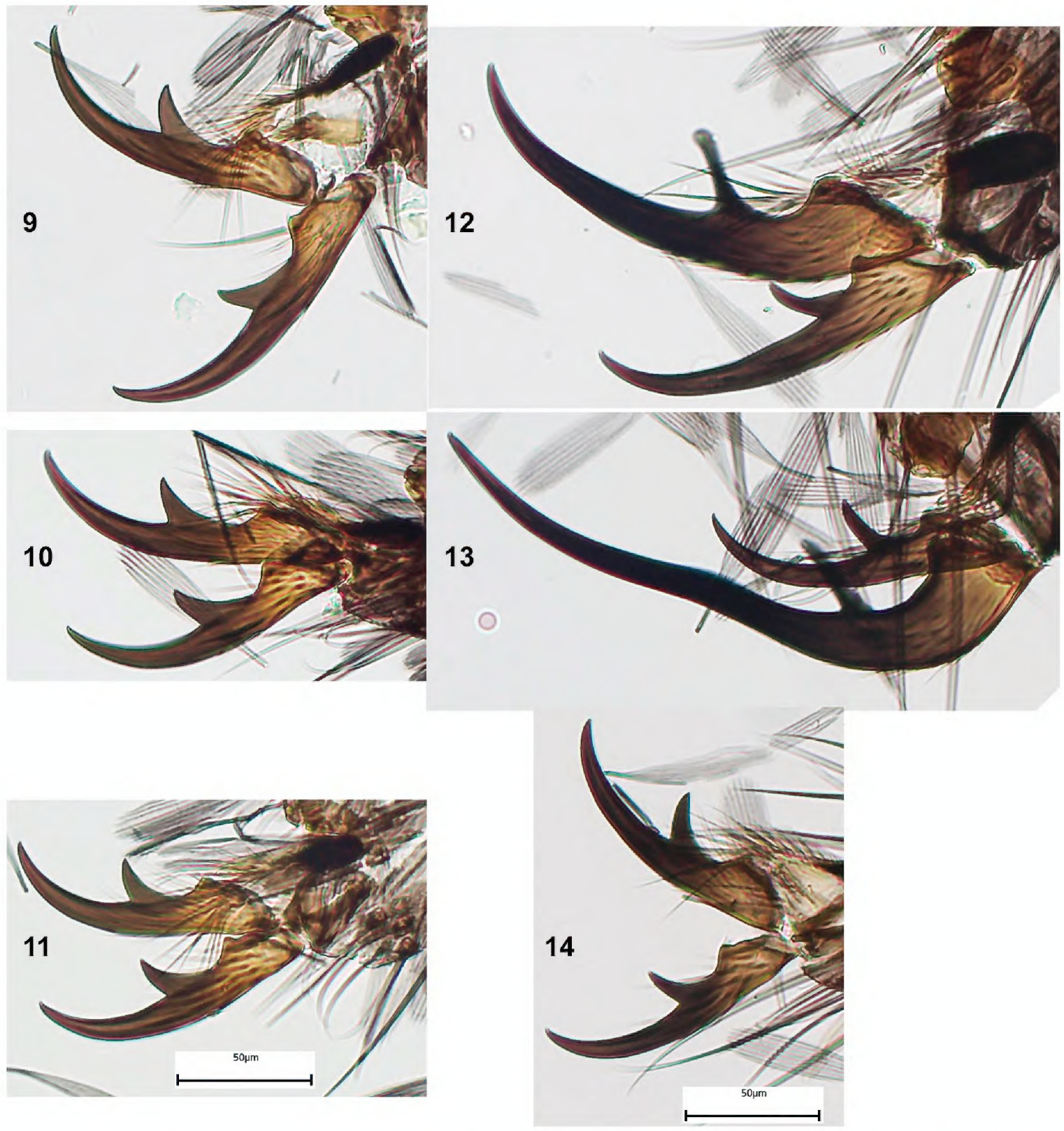
Figures 1–8. *Aedes punctor* gynandromorph: **1.** Dorsal view of head with bilateral dimorphism of antennae and palpi; **2.** Bilateral dimorphism of wings; **3.** Ventral view of head and prothorax with dimorphic chaetotaxy; **4.** Lateral view (right side) of thorax of female; **5.** Lateral view (left side) of thorax of male; **6.** Ventral view of abdominal sternites with laterally dimorphic chaetotaxy and scaling; **7.** Dorsal view of abdominal tergites with laterally dimorphic chaetotaxy and scaling; **8.** Gynandromorphic genital structures with fully developed male genitalia, unpair female cercus (red arrow), and spermatheca with only one spermathecal capsule (green arrow).

tween the two conditions. Bilateral individuals are nevertheless likely to be gynandromorphs.

Although bilateral gynandromorphs are easier to recognize than polar or ambiguous forms and intersexes, all publications on *Ae. punctor* only describe the latter (Edwards 1917; Brelje 1923; Shute 1926; Happold 1965; Packer et al. 1986; Kronefeld et al. 2014). Yet, with at least nine such reports (including the present one), *Ae. punctor* generally counts for more sexual aberration records than other *Aedes* species.

Since the present specimen was reared from wild-caught larvae and only recognized after killing, its biting behavior cannot be known. However, some of the studies mentioned above reported man-biting in the field, which indicates that even modified male or aberrant mouthparts may enable successful skin piercing and blood-sucking (Edwards 1917; Happold 1965).

With regard to the appearance of a single spermathecal capsule it should be noted that the normal condition in the majority of culicines is three capsules (Wilkerson et al. 2021). I have confirmed this in a normal specimen of *Ae. punctor* from the same batch as the gynandromorph. All three capsules measured 111 µm. The gynandromorph capsule size (86 µm) lies in the range of other aedine spermathecal capsules (75–100 µm in *Ae. aegypti* according to Wilkerson et al. 2021).



Figures 9–14. Typical *Aedes punctor* tarsal ungues: **9–11.** Female; **12–14.** Male. Upper row = fore-leg; middle row = mid-leg; bottom row = hind-leg.

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